

CHARACTERIZATION OF NEW PRODUCT DEVELOPMENT (NPD) MODELS APPLICABLE TO ENHANCE THE OVERALL PERFORMANCE OF THE APPAREL INDUSTRY

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ABSTRACT

The New Product Development (NPD) is one of the emerging trends among the leading apparel industries to gain and maintain the competitive advantage. The consumers are demanding for value-added innovative products at competitive prices. Hence, the apparel producers are faced with immense pressure to produce new products with unique features at competitive prices. Therefore, apparel industrialists are insisted to follow systematic NPD process models and with shorter cycle times. In the study, various NPD process models from a verity of diversified industries were critically evaluated, to examine the appropriateness using relevant Performance Indicators (PI) and characteristics. Such evaluation criteria were characterized to screen the most effective NPD models to reflect the unique features of the product design and development operations of the apparel industry. As concluding remarks, the study shows directions for academics and practitioners to develop result oriented NPD models specifically adoptable for apparel industry.

KEYWORDS: Apparel Industry, New Product Development Models, Performance Indicators

Received: Apr 26, 2016; **Accepted:** May 13, 2016; **Published:** May 20, 2016; **Paper Id.:** IJTFTJUN20161

1. INTRODUCTION

New Product Development function is one of the riskiest and critical activities in a successful manufacturing firm (Bruce & Biemans, 1995; Craig & Hart, 1992). Previous studies have emphasized on the importance of a systematic product development process to improve the probability of product development success (Cooper, 2008; Griffin, 1997). Griffin identified that the “the best companies are more likely to use some type of formal NPD process than the rest”. Cooper, R. defines new product as a particular product which has been in the market for three years or less, also undertakes them for further extensions and significant improvements. Although NPD literature evolved from 1960’s, effective NPD processes and models were discussed and evaluated implementation after 1990’s (Griffin, 1997). In the study, various theoretical models and conceptual frameworks were critically reviewed mainly from peer reviewed journal articles, published conference proceedings, and thesis publications.

Even though, ample research has been published in NPD and NPD models, most of them were discussed in marketing and strategic management stand point. NPD involves high risks and tremendous investment in terms of many functional areas, including product design and development. Because of the existing gaps indentified through the published literature on NPD models in apparel design and development, there is some inspiration coming from NPD models developed from other industries.

The most of the NPD models, methods and tools were developed as customer centric to screen product ideas in terms of product attributes. Certain tools used for transferring customer requirements to technical specifications such as Kano model, Quality Functional Deployment (QFD), House of Quality (HOQ), and Analytical Hierarchy Process (AHP). Apart from those various other conceptual frameworks exist in the literature to elicit the NPD process in a generic way. The “Stage-Gate” system is the most often cited NPD model in the literature for several decades as this is one of the most widely adopted model in well-known industries. In modern concepts such as Electronic-NPD, opens up the gates for adding knowledge management to NPD and which will eventually facilitate more product and process innovations.

Most of the literature has been found in the area of Marketing and Management domains, where a very few literature is available in from the product engineering stand point. Peters, A. J. (1999) states that typical NPD models are aimed at management, designing or were developed for specific industry needs. In modern approach, rather than individual functional engagement, more collaborative approaches had proven the new product success (Yang & Yu, 2002, Nambison, 2002). There are studies presented with collaborative product development, co-design, cross-functional models, and participatory design development with involvement of the Information Technologies (IT) (Chenyl, J., 2010). Another proven studies presented the successful innovations were taken place because of intimate collaboration between end user and innovator (Chesbrough, 2003). Su et al. 2006 states that customer knowledge has become indispensable for developing innovative products.

This study undertakes systematic literature review on existing NPD models. This literature review expounds product design to delivery mainly in terms of technology aspects. Overall objectives of this paper are threefold. First, we provide a systematic review of existing NPD models which are mainly published in consumer goods industries in different countries including apparel. NPD models which are more related to industrial goods did not make into consideration as industrial companies conduct NPD in a different way compared to consumer goods (Workman, J.P., 1993). Second, those models are critically assessed for evaluate the applicability for new apparel product development. Third, we identify the limitations of those models and discuss the possibilities for future work which are demanded to further foster those models in new apparel product development.

Apparel context has selected for the study, as it is the most prominent industry in developing countries which is the largest employment provider in those economies. Similar attention to this industry can be seen in developed countries in terms of experiencing diverse innovative readymade apparel commodities. Recently, apparel industrialists are enthusiastic in adopting practical NPD models which is becoming a necessity in upgrading the industry from assembly to full-package production. Absence of systematic Apparel Product Development (APD) models and processes will end up with unacceptable products and will break the customer relationships.

2. METHODOLOGY

The existing literature on new product development is vast. Main focus of the study is to evoke appropriate NPD models for apparel industry and identify future areas for improvements. Therefore, systematic literature survey was conducted using 75 peer reviewed journal articles from marketing, management and R&D journals from credible databases, such as Science Direct, JStor, Emerald Insight, Google scholar etc. Initially, literature has been reviewed across several manufacturing fields, which has the possibility to be applicable for apparel before entering apparel manufacturing domain to begin with. Afterwards, there are 40 sources productively used to critically review the available NPD process models and the phenomenon. In addition to that, there were 8 literature sources (shown in Table 3) were used to express

the demand of systematic NPD process models to apparel product development. Finally, there are 12 models were evaluated using key performance indicators which were extracted from aforementioned 8 apparel related journal articles. Figure 1 depicts the entire screening process starting from initial literature survey to critical review of chosen NPD models.

The rest of the paper is structured as follows. In section 3, generic NPD models were discussed and also presented the review of their applicability for apparel context. In section 4, the review of conceptual and practical NPD models which were originally designed for apparel context, were presented. Section 5 is the data analysis that is evaluation of the applicability of the chosen NPD models for apparel industry. Section 6 depicts the emerging trends which are related to the field of study.

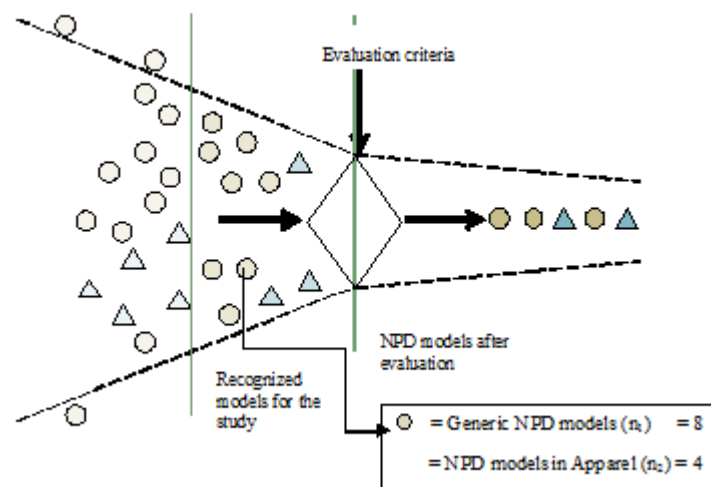


Figure 1: The Illustration for this Research Intervention

3. GENERIC NPD MODELS AND REVIEWS THEIR APPLICABILITY FOR APPAREL

Many leading companies developed their new product development processes inspiring from stage gate system. In this system, whole project is sectioned into distinct stages and evaluation criteria are set at the end of each part of the project. Those evaluation criteria will be act as the gate for next stage of the project. Systematic stage gate processes are road maps which support to define discrete stages of entire process from idea to launch and key importance is each stage is typified by a Go/Kill decision point or gate that will quantitatively and qualitatively evaluate the project before preceded to the next stage. The early generations of stage-gate processes such as Phased Review Process was very engineering driven that addresses strictly on physical design and development of the product (Cooper, 1994). New generations stage gate systems treat each distinct stage as cross functional team effort, marketing and manufacturing involvement are considered as integral part of the product development process. Stage Gate model promotes substantial business and marketing engagement together with thorough manufacturing assessment for successful new product launch (Cooper, 1994). Most of the conventional product development process models are sequential. Recent stage gate systems facilitate parallel of concurrent processing that will improve flexibility and reduces unnecessary time lapses in between the process stages.

The third generation stage gate system improved flexibility by having fuzzy gates that permitted conditional Go decisions depending on the situations. Process stages could be overlapped but focused with the resource availability in the organization. Subsequently several improvements were followed typical stage-gate system. Stage- gate model embark with

open innovation concepts to promote more innovations. Manufacturing companies are becoming more open to product development approaches that define product based on what people need, and creating experiences for the consumer rather than simply designing products (Sanders & Stappers, 2008; Raymond, 2007).

There were some sequential NPD models were published by Urban and Hauser (1980), Gruenwald (1992) and Himmelfarb (1992) in early stages of NPD; however those models were restricted to rationalize the interrelated process activities product design and development. Those models are useful to identify the list of activities which are involved in the product development process and other than that those models are not facilitated in current complicated product development processes. Several sequential processes were published at early stages of developing NPD process models, subsequently, those models could not support for interrelated complex process functions in product development. Most of the sequential models were consist in nature of representation, which views the series of activities in NPD from idea generation, market/ technical assessment, concept development, prototyping and ultimately finished testing (e.g. Handfield et al., 1999). Subsequently, parallel or concurrent product development process models were introduced to overcome the issues related to sequential processing. In concurrent models, product development occurs simultaneously at relevant multiple departments and that leads to optimize the product development cycle time.

Erhorn and Stark (1994) initiated an integrated approach, where product development operates simultaneously at multiple departments as cross functional integration. A supplier integrated NPD model was introduced by Handfield et al. (1999), in that model process flow was clearly highlighted and provides opportunities for supplier integration at various points of the process. That will accommodate more supplier involvement for new product development success by engaging focal suppliers' capabilities and design expertise, conducting technology risk assessments and evaluating the risk against the probability of success with the support from the supplier.

In 1999, Peters, A.J. and the research team presented a generic model for New Product Design & Development (NPDD) for small medium industries. That was a detailed identification of each activities of a NPDD process from design to delivery. Process iterations and the information flow also encouraged in the model and that was illustrated under "Facilitation Issues". However, the model is not clearly described how process iterations are operated and how the collaborators are involved in the information flow. Quality Functional Development (QFD) methods were deployed in designing many NPD process models in various industries including apparel. QFD is a method implemented to facilitate in developing marketable products with product attributes desired by the customer (Griffin, 1992). In this study, one of those models, i.e. QFD's interaction matrices (Griffin, 1992) was considered for the review.

Open Innovation principles emerged as an extension version of external collaborations which have led to accelerated and enriched the New Product Design, Development and launch. In wider perspective, Open Innovation is defined as leverage external sources of knowledge to drive internal growth (Chesbrough, 2003). In this approach, active customer engagement is coordinated in new product development than conventional product development (Sawhney and Prandelli, 2000; Hobo et al., 2006). The open innovation practices will provide a normative guide for organizational growth by inspiring best practices from external sources. Especially lead users may generate innovative ideas (Fuller & Matzler, 2007) and probably they have the potential to suggest feasible plan to end up with commercial product. However, there is a high risk when exposing new product strategies to external teams.

The Electronic New product Development (E-NPD) is emerged from knowledge management concepts and intention of this model was to create core knowledge repositories and the information interdependency between all

components of the value chain (Yang, Yu, 2002). In addition, authors highlighted, successful product development projects need participation of many experts from cross functional departments with various knowledge domains. However, NPD is often described as continuous process of learning (Madhavan and Grover, 1998; Sarin and McDermott, 2003) and the knowledge management view emphasizes acquiring knowledge through learning processes (Madhavan and Grover, 1998; Sarin and McDermott, 2003). Further, Knowledge Innovation is explained as core activity of NPD and knowledge acquisition, protection, integration and dissemination also explained as key directions of the model development. There were some directions for applications of electronic tools presented under E-NPD model.

Virtual customer integration initiated in manufacturing of high-tech industries and transferred some techniques into manufacturing of consumer goods. This technology becomes popular among apparel designers and customers. Virtual customer integration is beyond web based market approaches and those models will absorb customer knowledge & experience on products explicitly. Such customer responses on virtual products will reduce NPD failures by early detecting the customer acceptance of the final product. The Web, in combination with virtual reality (VR) and augmented reality (AR) technologies, is the enabler for virtual customer integration (Fuller & Matzler, 2007). VR based simulator involvement is proven as advantageous and beneficial in many fields (Rupasinghe, 2011).

Virtual New Product Development Team concept is also an emerging concept that will enhance the New Product Development by optimizing the human skill deployment. More of the functions are decentralized, no matter their physical placement, collaborated their work with the support of novel electronic communication technologies in cost effective ways (Hertel et al., 2004). Schmidt et al. (2001) find that virtual NPD teams are generally more effective than conventional co-located NPD teams. This concept facilitates to optimize human skill allocation (even geographically dispersed human resources) by pooling of entire work force in an organization.

4. REVIEW ON PUBLISHED NPD MODELS IN APPAREL CONTEXT

In this section, NPD models which was inherently designed for Apparel industry, has been discussed. Although apparel development process varies substantially from the other product development processes (May Plumlee & Little, 1998), some apparel manufacturers have been used generic models and concepts such as QFD in apparel product development. As per May Plumlee & Little (1998) there are inherent qualities of apparel development need to be considered when designing normative process models. In addition, during this reviewing process, other applications of NPD models will be evaluated. First, apparel products are designed as seasonal lines or groups of products rather than individual products. Second, several product lines produces within a year, Hence, stages of the development process may overlap. Third, the strategy for developing any one product in the apparel line may differ from another product. Having considered these limitations, a conceptual model named, No- interval coherently phased product development model for apparel (NICPPD) was developed with delegating the responsibility of apparel product development among four functional divisions; Marketing, Merchandising, Design & Development, Production. Main model of NICPPD illustrates overview of the six phases of apparel product development process and this is followed with other six models which elaborate an in-depth examination of each phase of the development process. This descriptive model did not show the customer integration and that gap was filled by the development of proactive product development integrating consumer requirements (PPDICR) model by the same couple of researchers in 2005.

The PPDICR model contributes to the theoretical understanding of apparel product development and which avenues can be adopted to capture consumer requirements. Effective use of this model will facilitate to develop

commercial product with adaptation of systematic method to capture consumer needs. In the sense, DeWitt (1995) indicate that internet and kiosk sales represent developing retail channels through which consumer preferences and create the purchase environment according to that. Apparently, eventual product success is determined the level of acceptance by the end consumer. Customer knowledge has become a valuable input in innovation process (Gassmann et al, 2005; Su et al, 2006) as they have the expertise knowledge in using for the particular purpose over years.

Functional, Expressive, Aesthetic (FEA) model can be used to identify end consumer needs with respect to unique apparel designing. Functional, Expressive and Aesthetic aspects are considered when assessing user needs and wants (Lamb & Kallal, 1992). The degrees of influence of those factors will depend on the product category. The target consumer is at the core of the model. Culture determines the connectivity between the customer and aforementioned factors, which need to be analyzed by the designer when designing customised apparel solutions. In rapidly changing environment culture will not be the factor to evaluate when acquiring their desires to apparel design.

Three stage design process (LaBat and Sokolowski, 1999) consists of three main phases in product design and development (a) problem definition and re-search, (b) creative exploration, and (c) implementation. Labat & Sokolowski (1999) applied this model for a textile product design project i. e. they redesigned of an athletic ankle brace. This model encourages for creative exploration of new products and lends a measure of quality assurance of the novel products.

5. EVALUATE APPLICABILITY OF THE CHOSEN NPD MODELS FOR APPAREL INDUSTRY

In general, Apparel products are not designed and developed as single product; they are designed and produced as product lines or product portfolios, which are undertaken with relatively low product life cycles. In the sense, Retailers plan product ranges for respective fashion seasons, hence, manufacturer need to reduce time elapses from order to market. To cater this dynamic situation standardized processes and procedures evolved among retailer, manufactures and rest of the supply chain entities. Key characteristics of prospect NPD models which is feasible for apparel NPD is evaluated using Table 1. In the last column of the Table 1 depicts the limitations of the applicability of these models and further elaborates the shortcomings to be addressed when developing such models explicitly for apparel.

Table 1: Review of the NPD Models

Ref. Code	Model Description	Core-Industry	Key Attributes	Limitations
General NPD Models in Diversified Industries				
A	Third generation Stage Gate model, (Cooper, 1994)	Wide variety of industries including consumer goods.	Short cycle times through fluidity of process stages and Fuzzy gates, Better prioritising of resources and sharper focus on NPD projects.	Fallibility – Need experienced project management approach in decision making to be benefitted from this process model
B	Concurrent process models Example: (Erhorn, Stark, 1994)	Many industries	Reduced product development cycle time, cost effectiveness,	No involvement with customer, Exchange of information with inter-departments only.
C	Generic model for New product design & development (Peters, 1999), UK	Diversified industries (Small & medium enterprises, (SME))	Provides overview of entire NPDD process from design to end distribution with detailed descriptions of each activity.	Designed for SME's. This is a generic model and there was no clue for practical implementation of the model.
D	QFD's interaction	Many industries	Evaluate customer	The focus of this model is

	matrices (Griffin, 1992), Japan	including Apparel	specifications of the product requirements and transfer them to organization's technical capabilities.	limited, no guidelines to integrate with corresponding resources
E	NPD process model, Handfield et al., 1999), USA	Diversified Industries	Supplier integrated NPD model. Suppliers are providing information directly and involved in decision making for purchase.	Additional decision making is needed when selecting suppliers as supplier involvement is more crucial in this model.
F	E-NPD model, (Yang & Yu, 2002), China	Diversified industries	Convergence of customer relationship & business processes, Integrate knowledge management system IT applications.	Knowledge management between cross functional teams is not logically demonstrated in the model illustration.
G	Virtual customer Integration, (Fuller & Matzler, 2007), Austria	Diversified industries both industrial goods and consumer goods	Reduce NPD failures, Improve market responsiveness, Reduce NPD cost	Customer share their knowledge with the basis of what they have experienced from the virtual product, they are not be able to comment on what they do not know about the product (e.g. materials) (Ulwick, 2002) Competitors may find information on competitive products.
H	Virtual New Product Development Team concept (Badrinarayanan et al., 2008)	Just a conceptual Framework	high quality solutions that lead to superior product quality (Atuahene-Gima, 2003)	Heavily depend on technology, nationality, ethnicity and cultural impact on communication, Temporal separation (Kerber and Buono, 2004)
Apparel Industry Specific NPD Models				
I	FEA consumer need model (Lamb & Kallal, 1992)	Apparel	Sensible method of designing functional garments. Culture bridge the connectivity of the main factors and customer.	No specific criteria on how to chose the correct mix of FEA factors
J	NICPPD model (May Plumlee & Little, 1998), USA	Apparel	Attention to details of product flow in each four functional divisions.	Most of the stages of product development were considered, nonetheless, internal or external resource involvement has not been attained.
K	Three Stage Design Process (LaBat and Sokolowski, 1999).	Apparel and other industries	Encourage creative exploration by providing structural approach for the product design	It is product oriented, NPD process is not brought forth.
L	PPDICR model, (May Plumlee & Little, 2005), USA	Apparel	Integrating customer requirements in each phase of the product development process	Need more empirical evidences for process establishment using this model.

Apparel industry is a buyer driven value chain, in that large retailers, marketers and branded manufacturers play vital role which are typically located in developing countries (Gereffi et al., 2003). Table 3 used to extract and present performance indicators which are used as measurements to evaluate the applicability of prospect NPD models for apparel

industry. These performance indicators are identified as prominent aspects for new apparel product development using literature.

Table 2: Key Determinants to Screen the Applicability of NPD Models to Apparel Industry

Source	Key Determinants to Screen NPD Models for Apparel	Performance Indicators
Bartley, 2005 Gereffi et al., 2001	Demand for high quality products	High Product Quality
Duke, CGGC Report	Adding design capabilities to the production of garments	Enhance Design capabilities
May-Plumlee & Little, 2006; Jones, 1995	Shorter Product development life cycles	Short PD cycle time,
Wheelright and Clark, 1992	Rapid responsiveness and greater flexibility	Market responsiveness
Cammett, 2006; Dicken, 2003	Reduce costs while satisfying customer tastes	Cost management
May-Plumlee & Little, 2006	Trend for developing marketable new apparel products and effectively integrating new technologies.	Advanced Technology Applications
Gupta, 2011	Demand for R&D, innovative design from Original Design Manufacturers (ODM)	Encourage Innovations
Nordås, 2004	need to use resources on monitoring and controlling trade in textiles and clothing	Optimum resource utilization

Numerous models including conceptual frameworks can be identified in NPD of hi-tech/ low-tech involved manufacturing environments. Most of the journal articles presented NPD models and framework and assessed them qualitatively in terms of market responsiveness, customer satisfaction etc. In this study, author wants to elaborate and discuss the applicability with quantifiable terms.

Table 3: Evaluation for Studied NPD Models for Apparel Industry

Performance Indicators / Measurements	Model Reference Code (from the Table 1)											
	A	B	C	D	E	F	G	H	I	J	K	L
High Product Quality	✓	✓	✓	✓	×	✓	✓	✓	×	×	✓	×
Enhance Design capabilities	×	×	✓	×	✓	×	✓	×	✓	✓	✓	✓
Short Product Development cycle time	✓	✓	×	✓	×	✓	✓	×	×	✓	×	✓
Market responsiveness	✓	×	✓	✓	×	✓	✓	✓	✓	×	✓	×
Cost management	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	✓
Advanced Technology Applications	×	×	×	×	✓	✓	✓	✓	×	×	✓	×
Encourage Innovation	✓	✓	×	×	✓	✓	✓	×	×	×	✓	×
Efficient allocation of development resources	✓	×	✓	×	×	×	×	✓	×	×	×	×

When NPD models from different fields are applied to apparel, the feasibility, benefit and limitation need to be analysed. Table 1 describes prominent NPD models from diversified literature sources for their key attributes and limitations for implementation. Stage Gate model is an appropriate framework even for apparel product development, however critical decision making is needed to overcome internal process barriers. Process model B is a good initiative for concurrent process models, however those models were able to satisfy only few NPD demands. In addition to that, process models C, D and E cater for particular areas in NPD, hence those models are needed more improvements to accomplish entire NPD process demands. Process models F, G, and H were introduced with the novel information technologies, also those models provide more opportunities for advanced NPD process designs. According to Table 4, those F and G models meet most of the performance indicators. There are few apparel based NPD models were published in the literature.

Process models I, J, K and L are also conceptual frameworks, though they are important to realize the fundamentals of apparel product development.

6. EMERGING AREAS IN NEW APPAREL PRODUCT DEVELOPMENT

In recent literature, there are several emerging trends are discussed in the field of New Product Development. Some novel concepts especially which can be applied for apparel are discussed in this section. Recent product development literature revealed the technology involvement and IT-based digitalization of the fashion industry intriguingly. Such adaptation have greatly influenced in product concept launch in general. Computer-aided design/computer-aided manufacturing (CAD/CAM) techniques play vital role in designing and visualizing textiles and clothing and that will reduces unnecessary product iterations. Researchers continue to explore rapid prototyping, body scanning and other innovative product development technologies to improve the development process (Istook, 2001). More recently, much virtual clothing simulation software can be used to exhibit accurate, efficient and marketable fashion products. (Kim et al, 2007). Augmented Realty with the aid of Virtual Reality has the potential to open up new markets and that will attract more customers. In addition, improvements in communication between retailers and producers through technology such as computer-aided design (CAD) and electronic data interchange (EDI) have contributed to shortening lead times (Bruce et al., 2004).

7. CONCLUSIONS

Most of the NPD models were aimed at management (e.g. Cooper, 1994), or at apparel designing (e.g. FEA model), or were developed for specific industry requirements (such as Product Introduction Model (PIM) at Lucas (Lucas Industries PLC, 1993). However, to optimize the success rate of the product, marketing, designing and manufacturing functions need to be integrated. Interpreting customer needs and then selecting technologies to satisfy those needs is drastically becoming a major task of the NPD. Ultimately the success of the new product is determined by which extent it could satisfy customer or human needs.

Sequential models lack the depth analysis of realistic concurrent nature of product development even cooper's third generation stage gate model. Cooper's model guides for certain extent but it is not specifically for apparel (May-Plumlee & Little, 1998). Earlier most of the product development models established considering only on the product development activities, subsequently, product development functional divisions or departments which those activities are being accomplished also incorporated. Nowadays companies are reinventing their development processes to become faster, leaner, and more effective while simultaneously improving smaller components within the segmented stages of the process (Cooper, 2008; Hines & Quinn, 2007).

With the conclusion of this systematic literature review, however, theoretical models are conceptually correct, those can be discouraged to implement in the industry. There is a need of practical new product development model to apparel, and those models should evolve as the result of empirical studies. Modern NPD literature depicts the higher tendency of using information technology mainly virtual prototyping and the simulation methods. In the stream of NPD literature, most of the NPD models and related publications were focused on industrial products and services with having long product life cycles. Few NPD models and strategies can be found in consumer goods mainly in apparel. Those models also had been developed in the view point of marketing and manufacturing. With the emerging trends in Information Technologies (IT), Material innovations, automated machineries equipments, there will be a rapid demand for new

functional apparel designs and developments. Therefore, the most productive new apparel product development models require the collaborative engagement of Apparel designers, Material developers, Garment technologists, Industrial Engineers along with the Marketers.

In this stream of literature, only handful of NPD models was identified in apparel sector and most of the published models also conceptual. Hence, this systematic literature review is worthwhile for apparel industrialists to inspire NPD strategies from other manufacturing industries. On the other hand, the evaluation criteria will provide guidelines to select most appropriate NPD models and tools for apparel industry. This dynamic industry is having its inherent characteristics and they are used as Performance Indicators in evaluating existing NPD models to apparel industry.

8. DISCUSSIONS

After dismantling apparel export restrictions, apparel exporters are seeking opportunities for presenting novel apparel designs with unique features and functions. Until the mid 1980s, consumers were less sensitive towards styles such as Levi's 501 jeans (Bhardwaj & Fairhurst, 2010). Apparel products are designed and produced as product line and that need to be considered when designing new NPD process models. Though Marketing and manufacturing functions are prominent in the new product development process, Product Design and Development is extremely important to minimize the new product failures technically. However, few empirical researches to develop NPD model focusing on product design and development functions. Robert Cooper, Guru of New Product Development, recommend changing NPD strategies and process models after each five years time to achieve higher standards. Most of the published conceptual models lay the foundation for understanding the generic phases and activities of NPD. Thereafter, they do not provide much on engineered a NPD model with resource allocation, process standardization, product development cycle time etc.

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